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(52) UK CL (Edition V )
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INT CL[7] E21B
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(54) Abstract Title
**Zonal isolation apparatus with flow valves controlled in response to sensor outputs**

(57) An apparatus which comprises a zonal isolation assembly comprising a solid tubular member 135 including an external seal 140, a perforated tubular member 145 coupled to the solid tubular member, a flow control valve 160 coupled to the perforated tubular member for controlling flow of fluid through the perforated tubular member, a temperature sensor 802 coupled to the perforated tubular member, a pressure sensor 804 coupled to the perforated tubular member for monitoring the pressure within the perforated tubular member, a flow sensor 806 coupled to the perforated tubular member for monitoring the fluid flow rate within the perforated tubular member and a shoe 155 coupled to the zonal isolation assembly and a controller 810 for monitoring the flow control valve, the temperature sensor, the pressure sensor and the flow sensor and for controlling of the flow control valves in response to the sensor outputs, wherein at least one of the solid and perforated tubular members is formed by a radial expansion process within the wellbore.

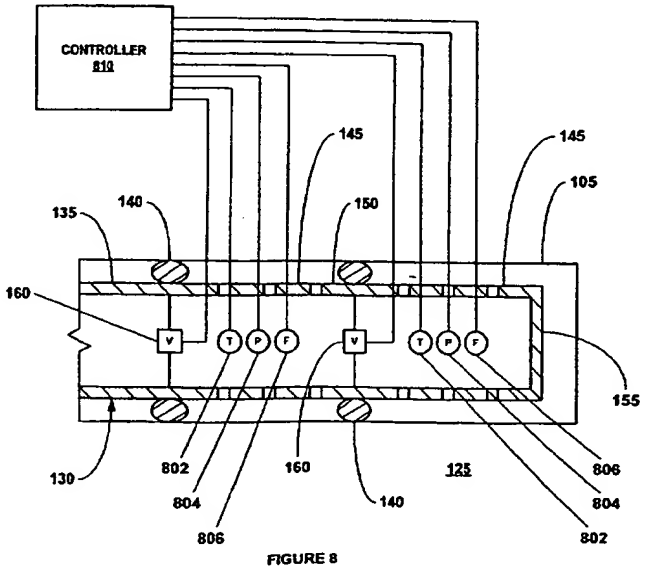
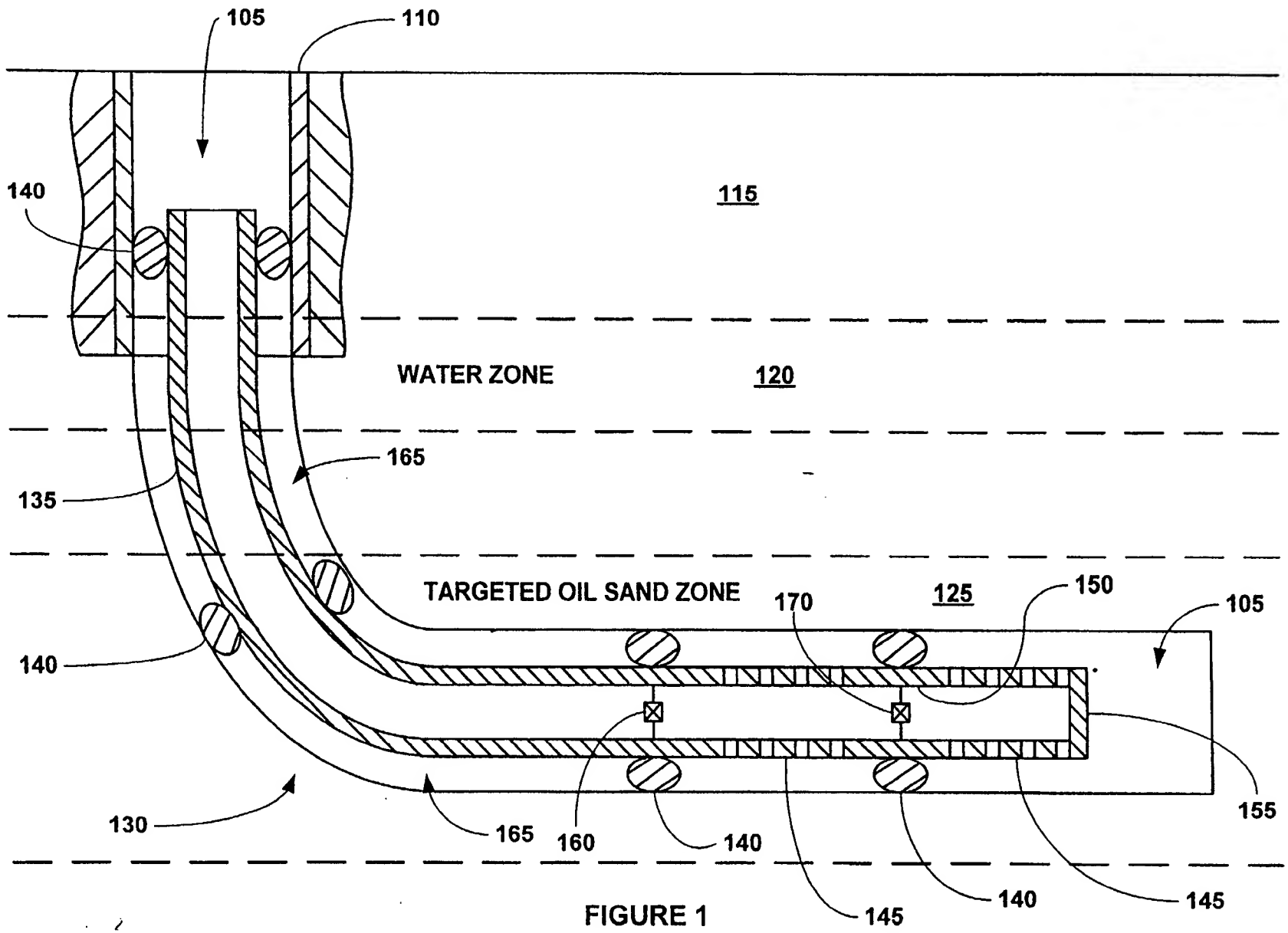



FIGURE 8

GB 2 382 828 A


105
110
140
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WATER ZONE
120
165
135
TARGETED OIL SAND ZONE
125
170
150
105
140
155
130
165
160
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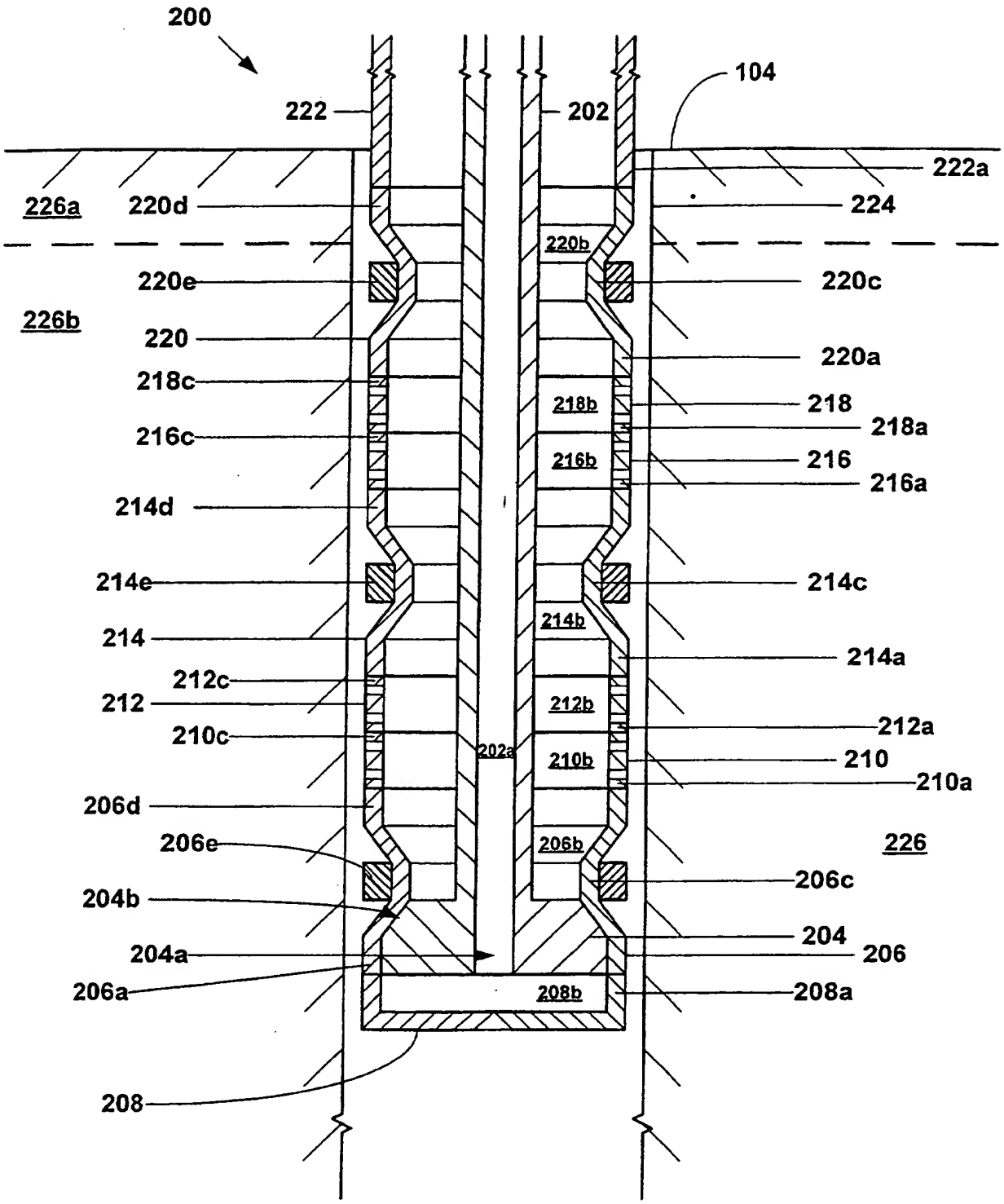
145
140
145

FIGURE 1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210b
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208a
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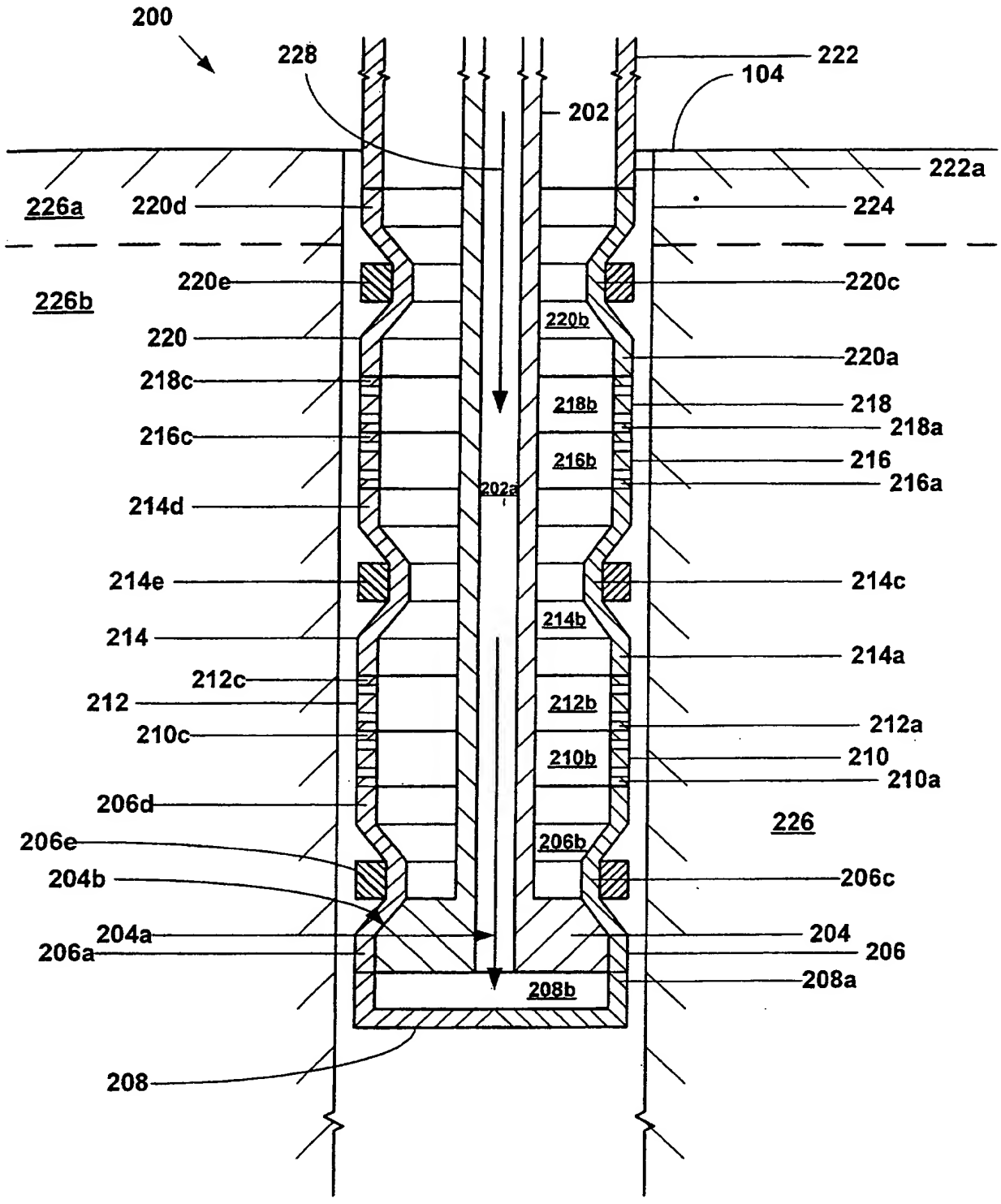
Fig. 2a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212a
210c
210b
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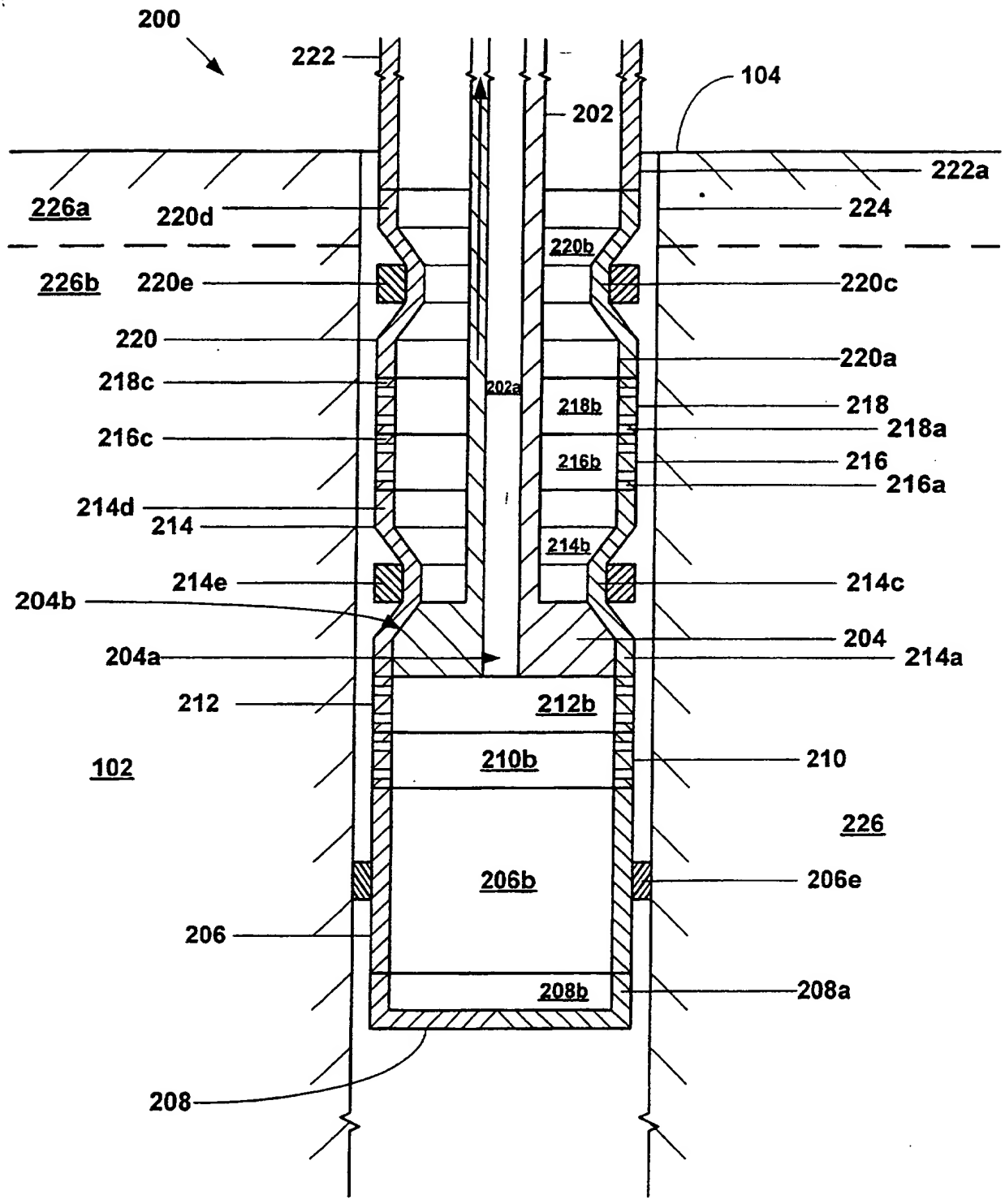
Fig. 2b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216c
216b
216
216a
214d
214
214b
214e
214c
204b
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204a
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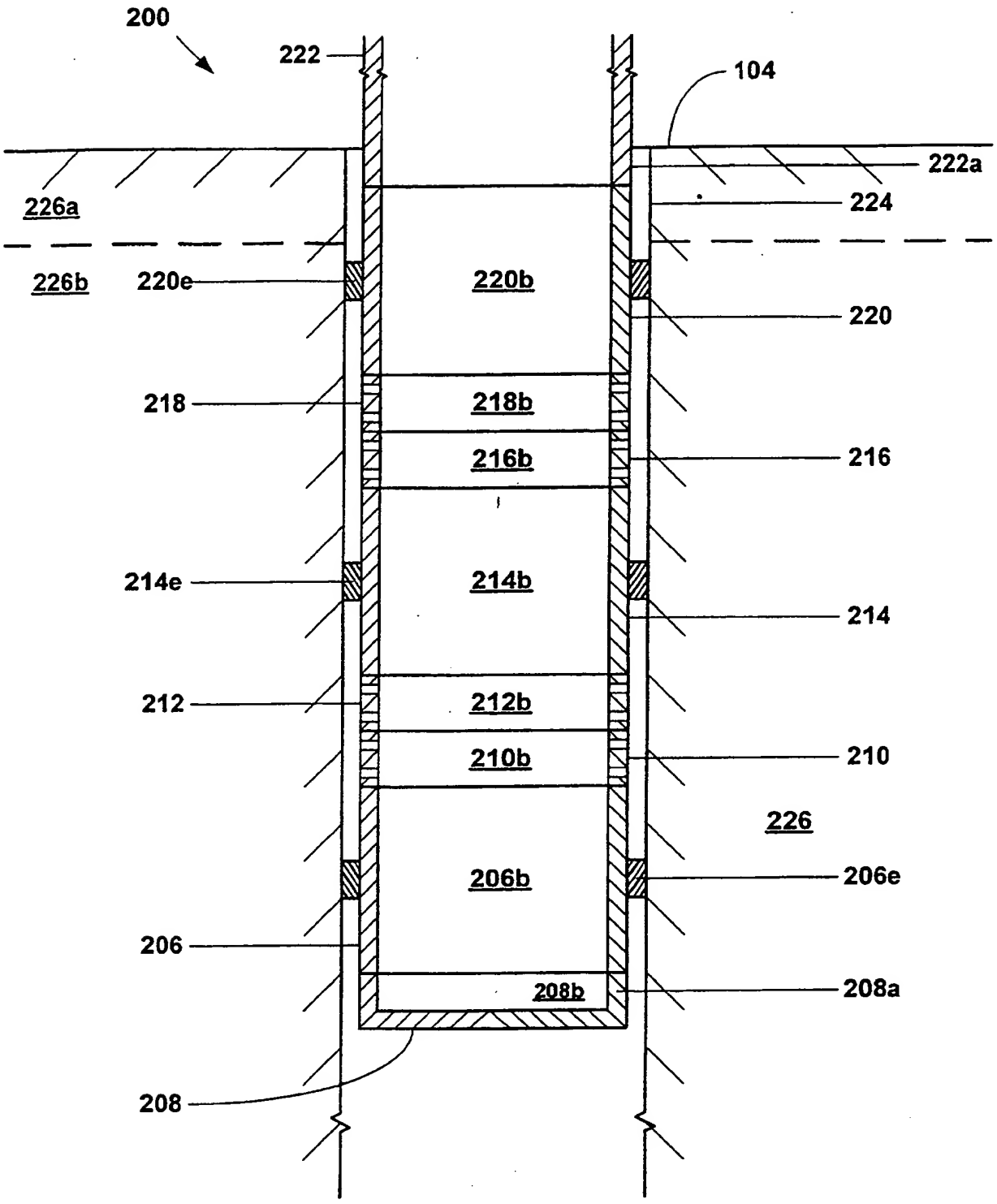
212
212b
102
210b
210
226
206b
206e
206
208b
208a
208

Fig. 2c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218b
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214e
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212b
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206b
206e
206
208b
208a
208

Fig. 2d

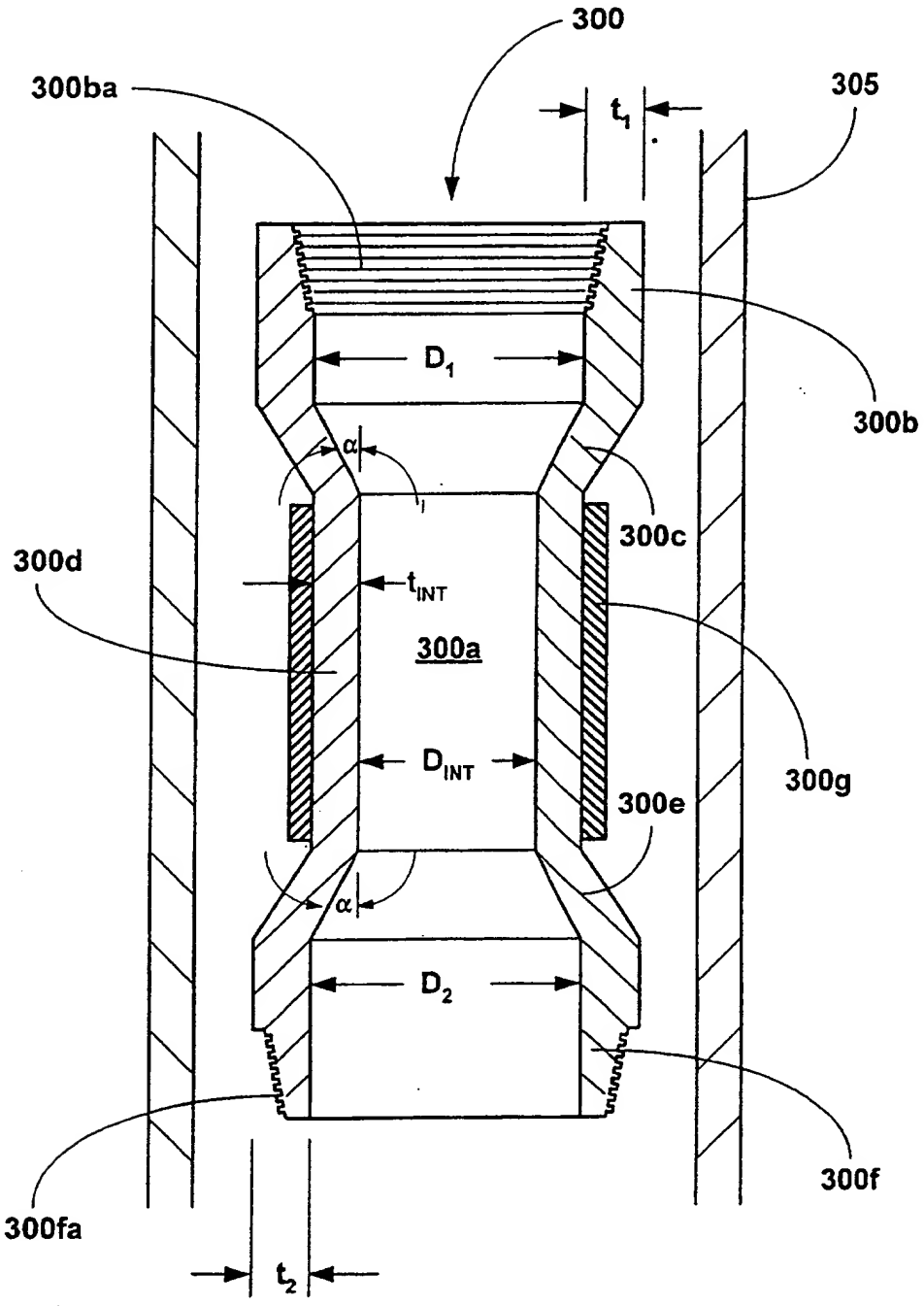

300
300ba
305
$t_1$
$D_1$
300b
α
300c
300d
$t_{INT}$
300a
$D_{INT}$
300g
300e
α
$D_2$
300f
300fa
$t_2$

Fig. 3

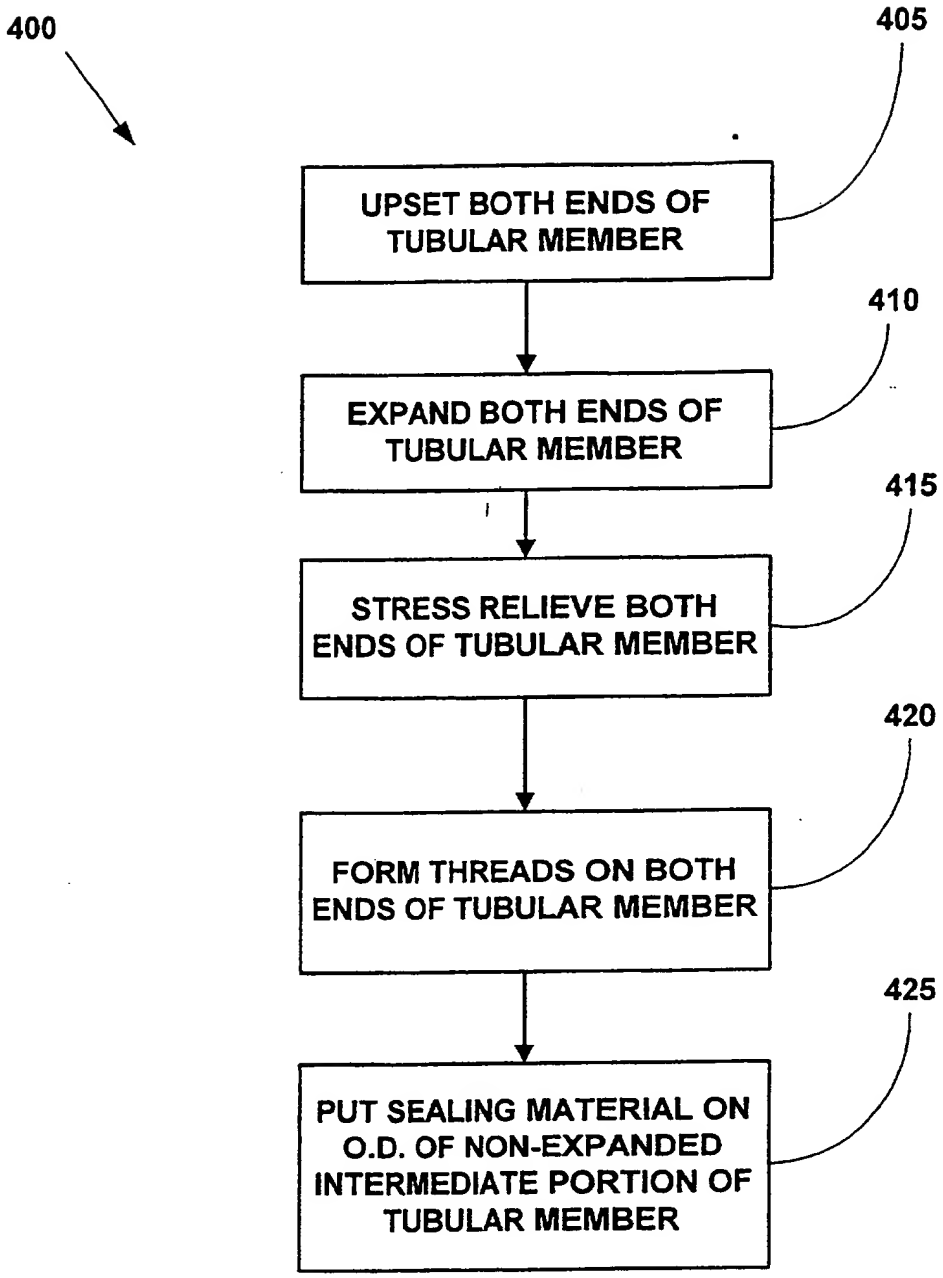
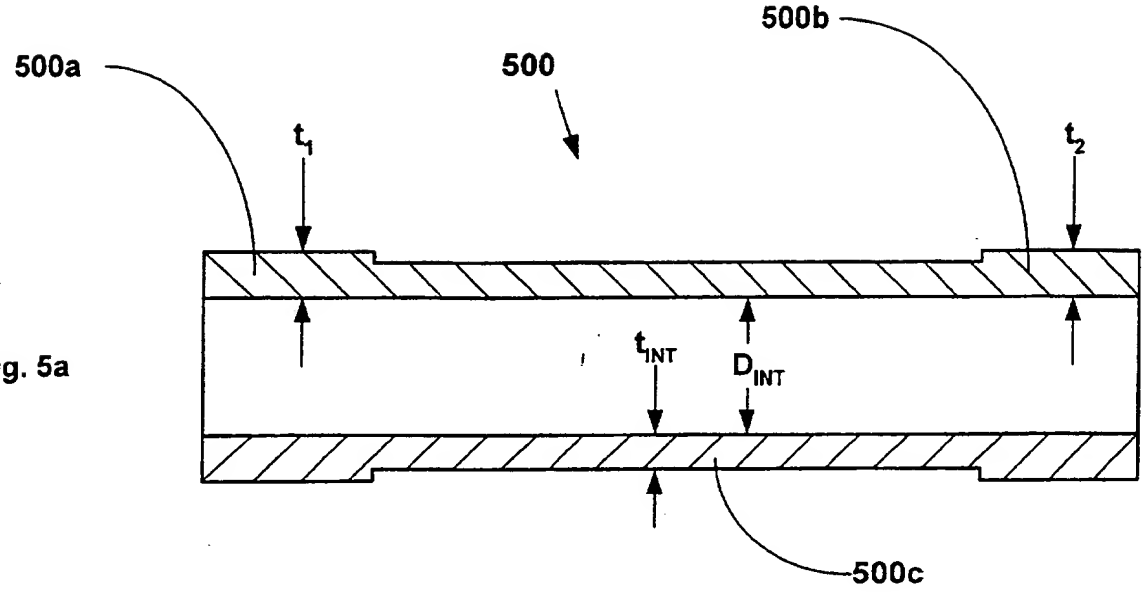

400
405
UPSET BOTH ENDS OF TUBULAR MEMBER
410
EXPAND BOTH ENDS OF TUBULAR MEMBER
415
STRESS RELIEVE BOTH ENDS OF TUBULAR MEMBER
420
FORM THREADS ON BOTH ENDS OF TUBULAR MEMBER
425
PUT SEALING MATERIAL ON O.D. OF NON-EXPANDED INTERMEDIATE PORTION OF TUBULAR MEMBER

Fig. 4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500a
500
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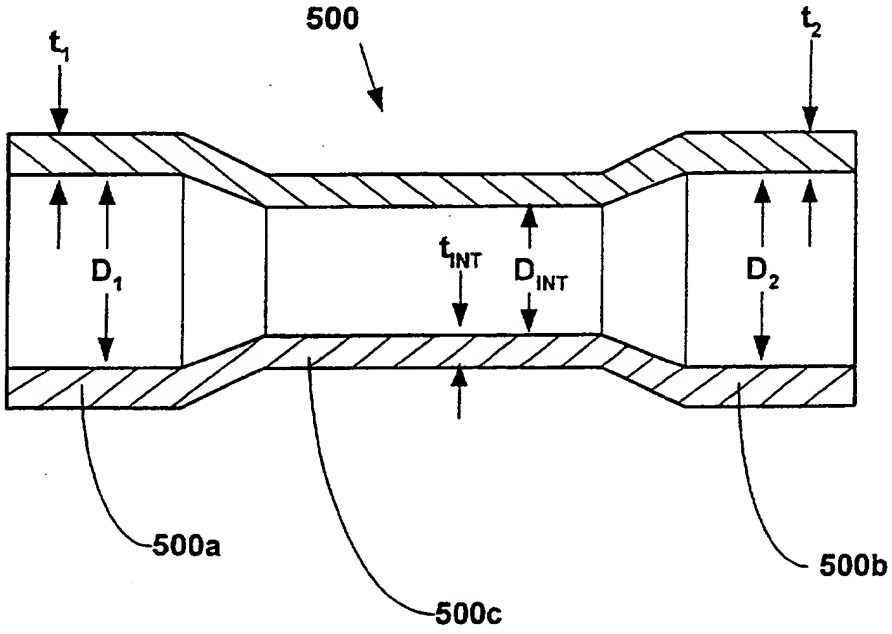
$t_2$
$t_{INT}$
$D_{INT}$
500c

Fig. 5a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$t_1$
$t_2$
$D_1$
$t_{INT}$
$D_{INT}$
$D_2$
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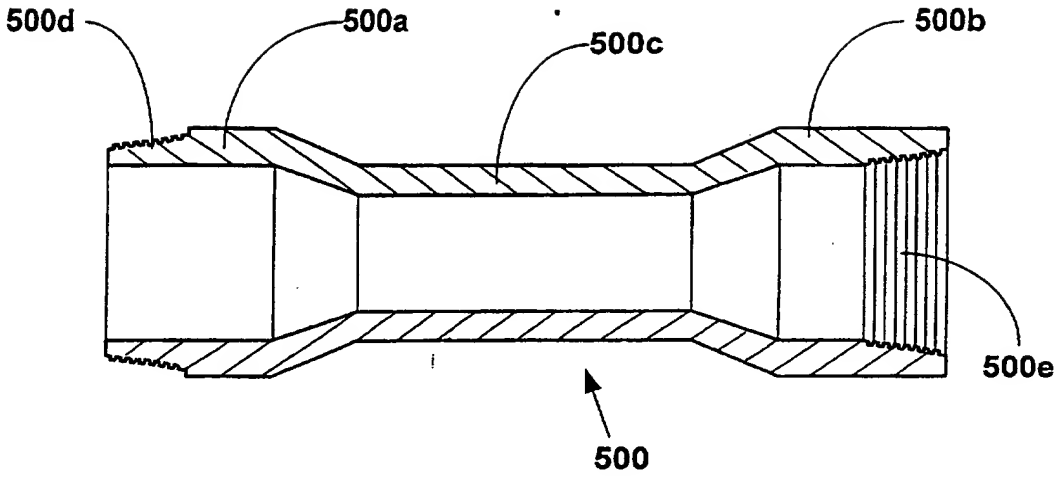
500c
500b

Fig. 5b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500c
500b
500e
500

Fig. 5c

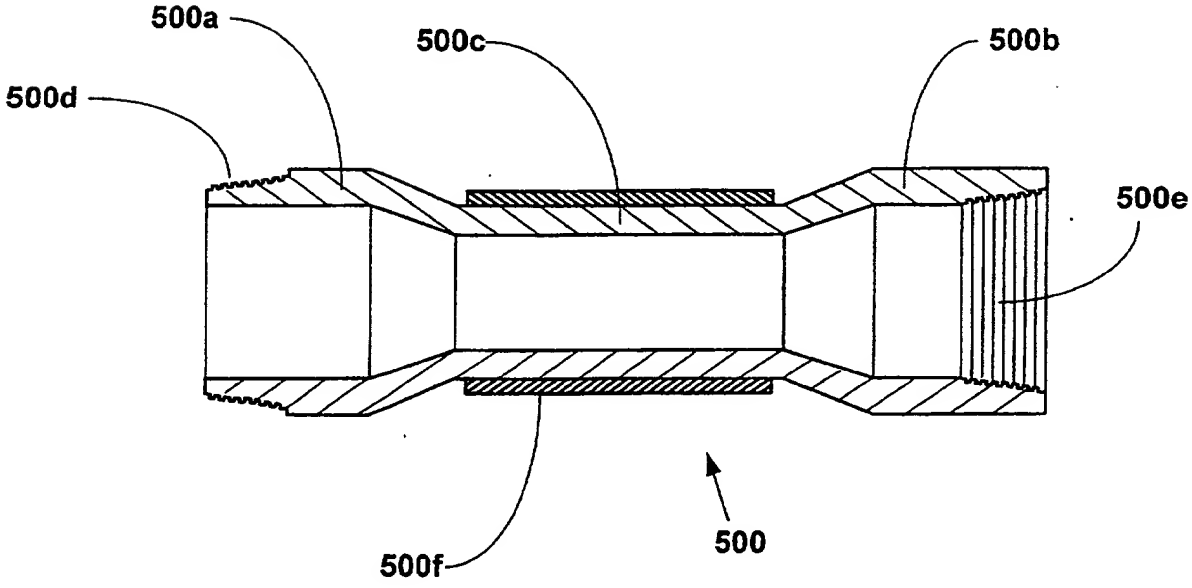

500a
500c
500b
500d
500e
500f
500

Fig. 5d

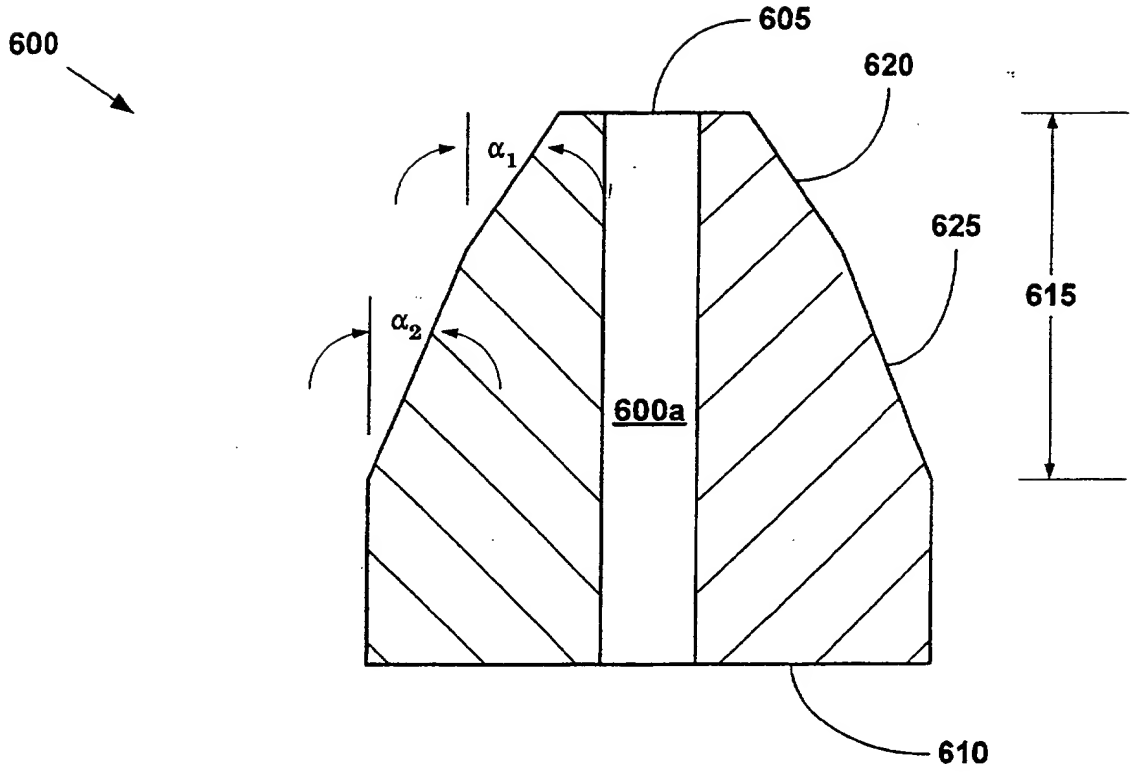



Fig. 6

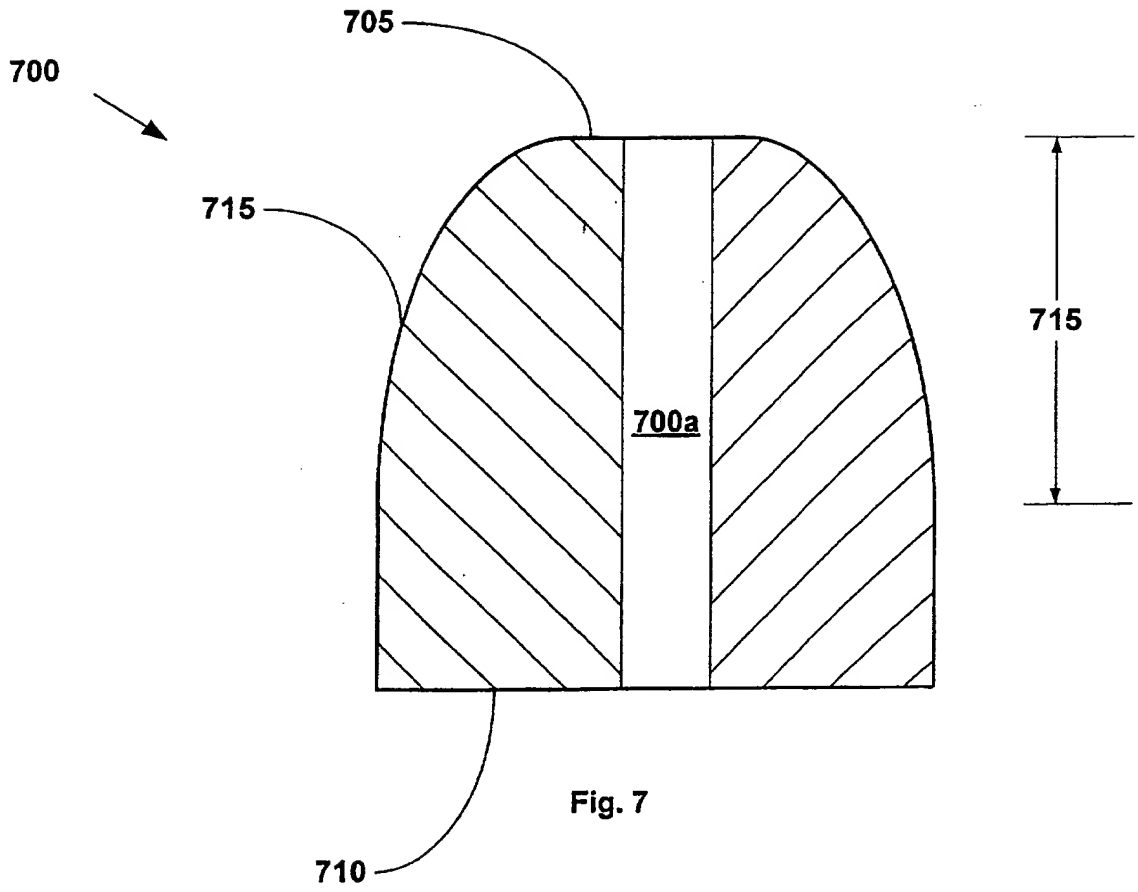
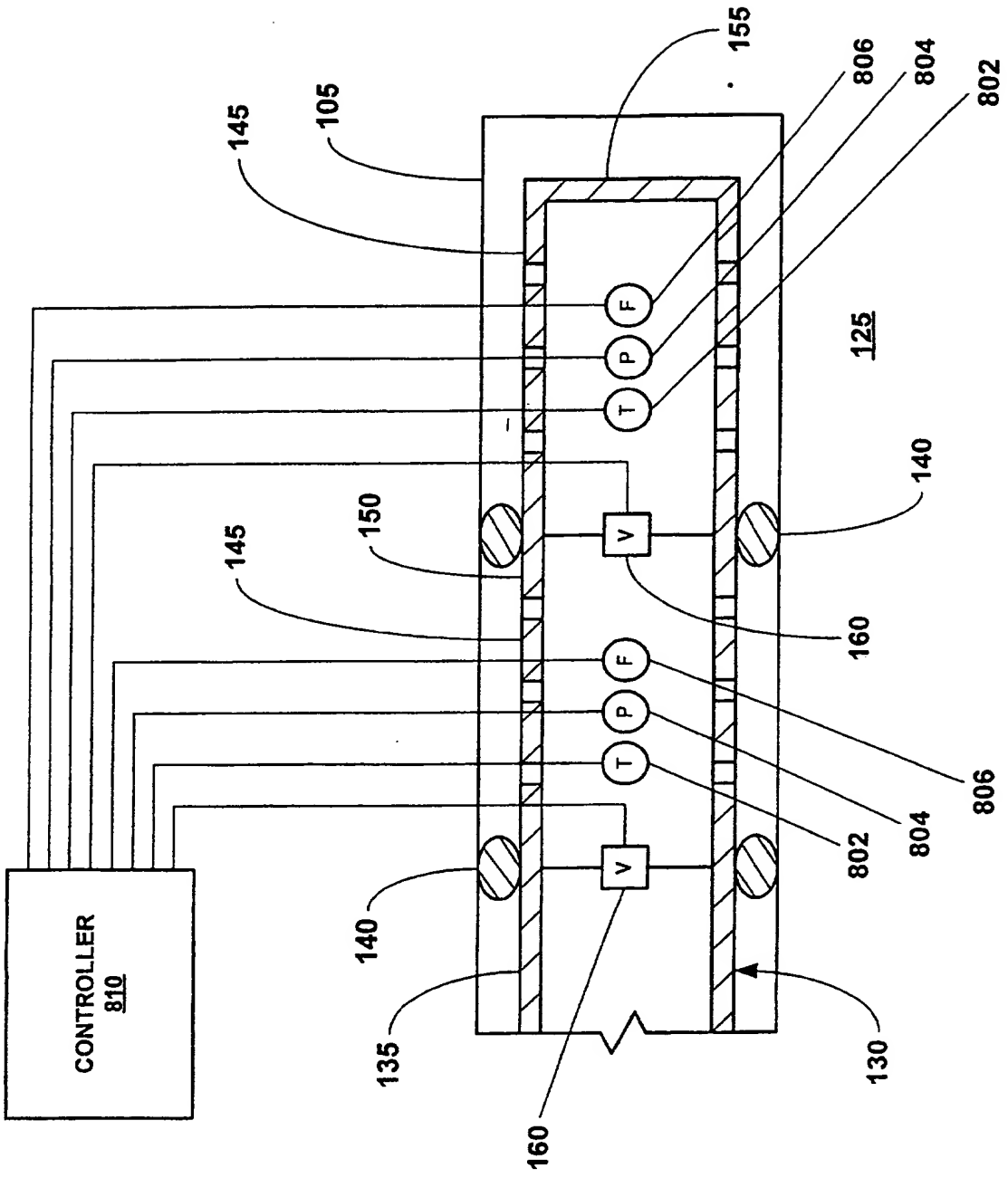



Fig. 7


CONTROLLER
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F
P
T
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130

FIGURE 8

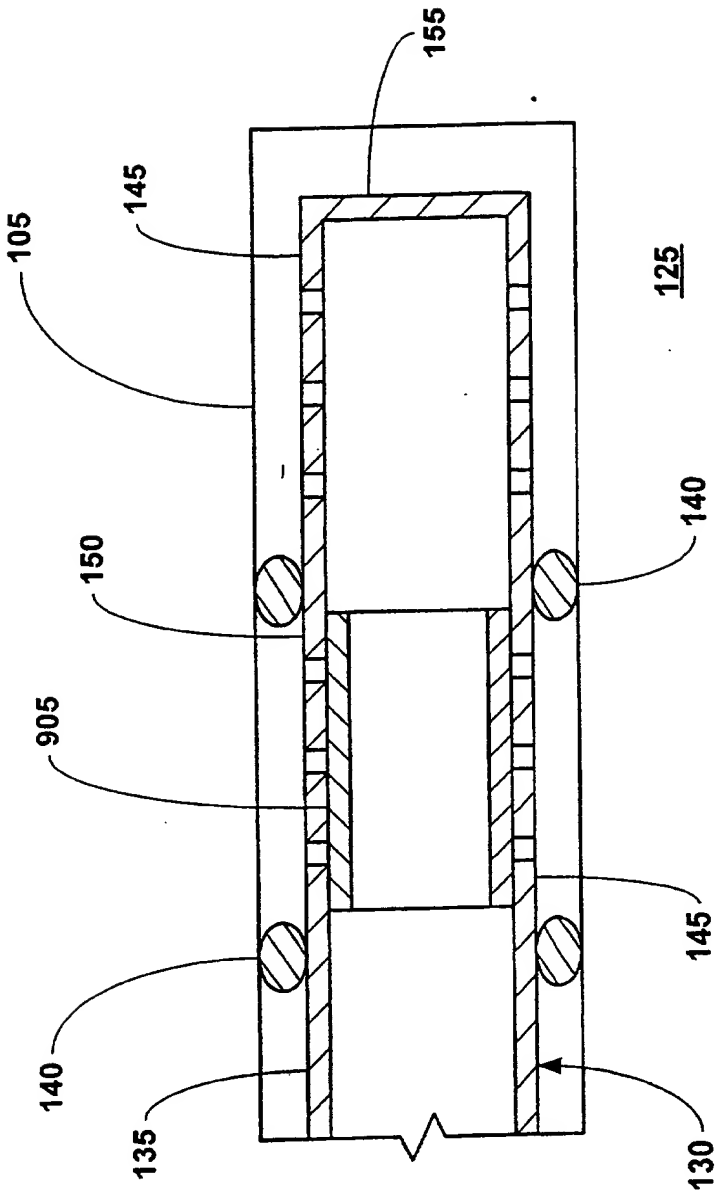
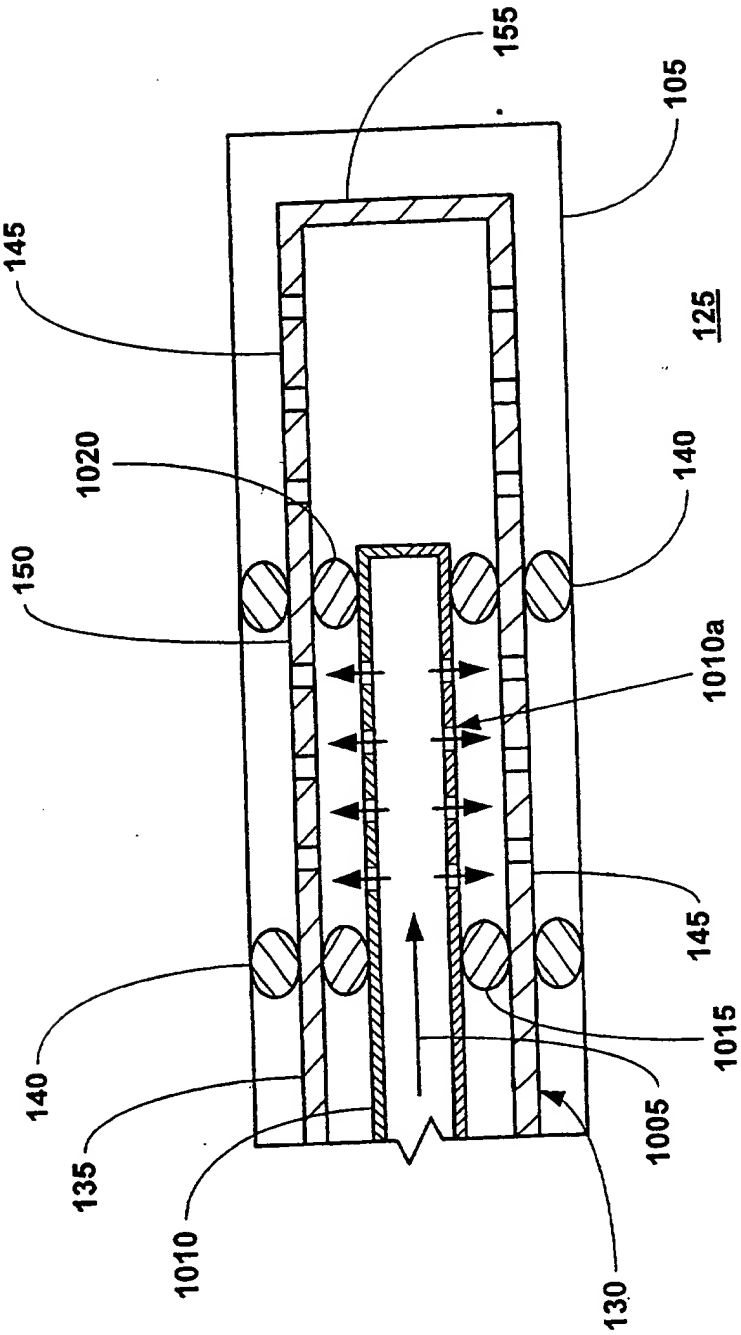



FIGURE 9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1005
1010
130

FIGURE 10

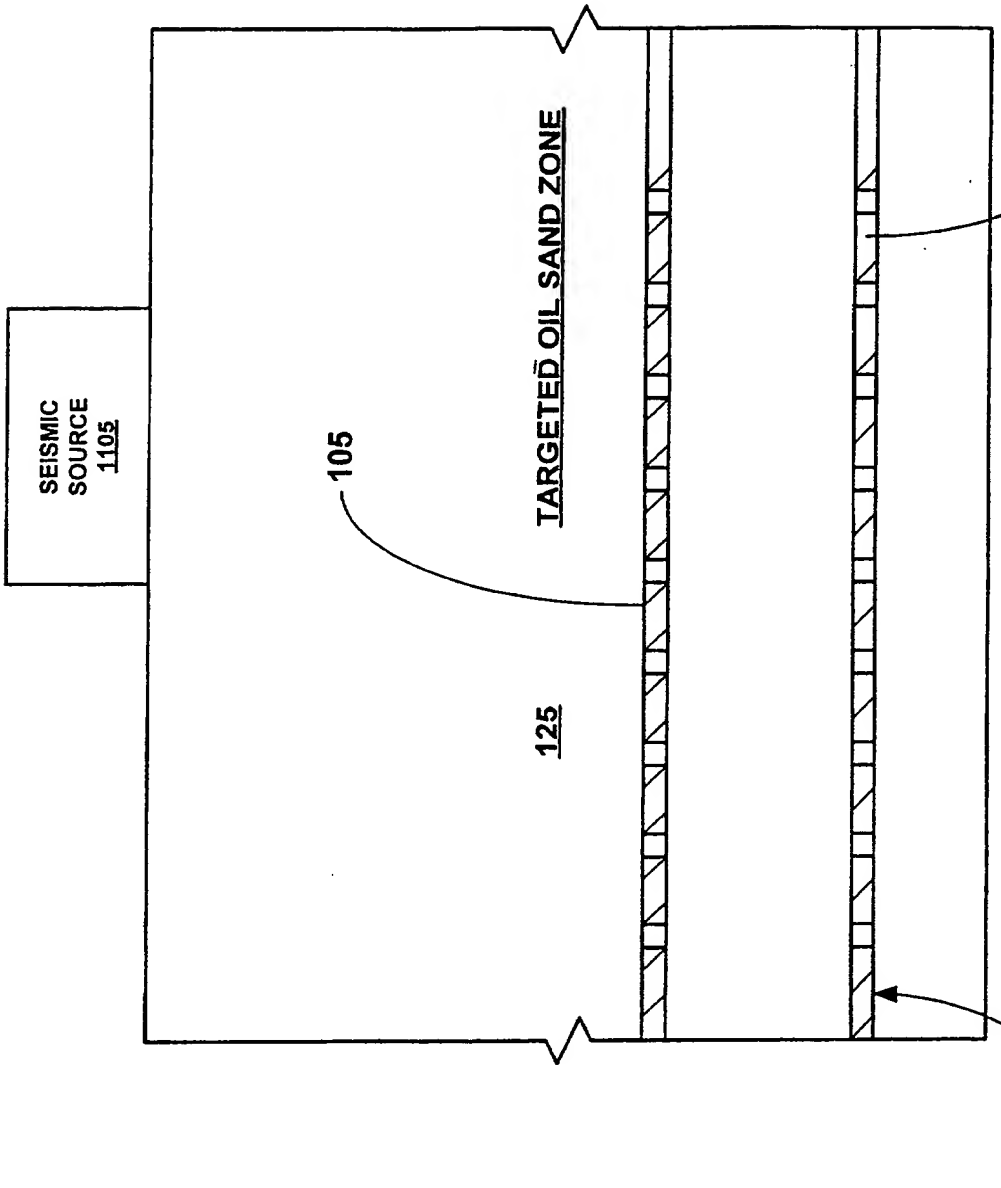
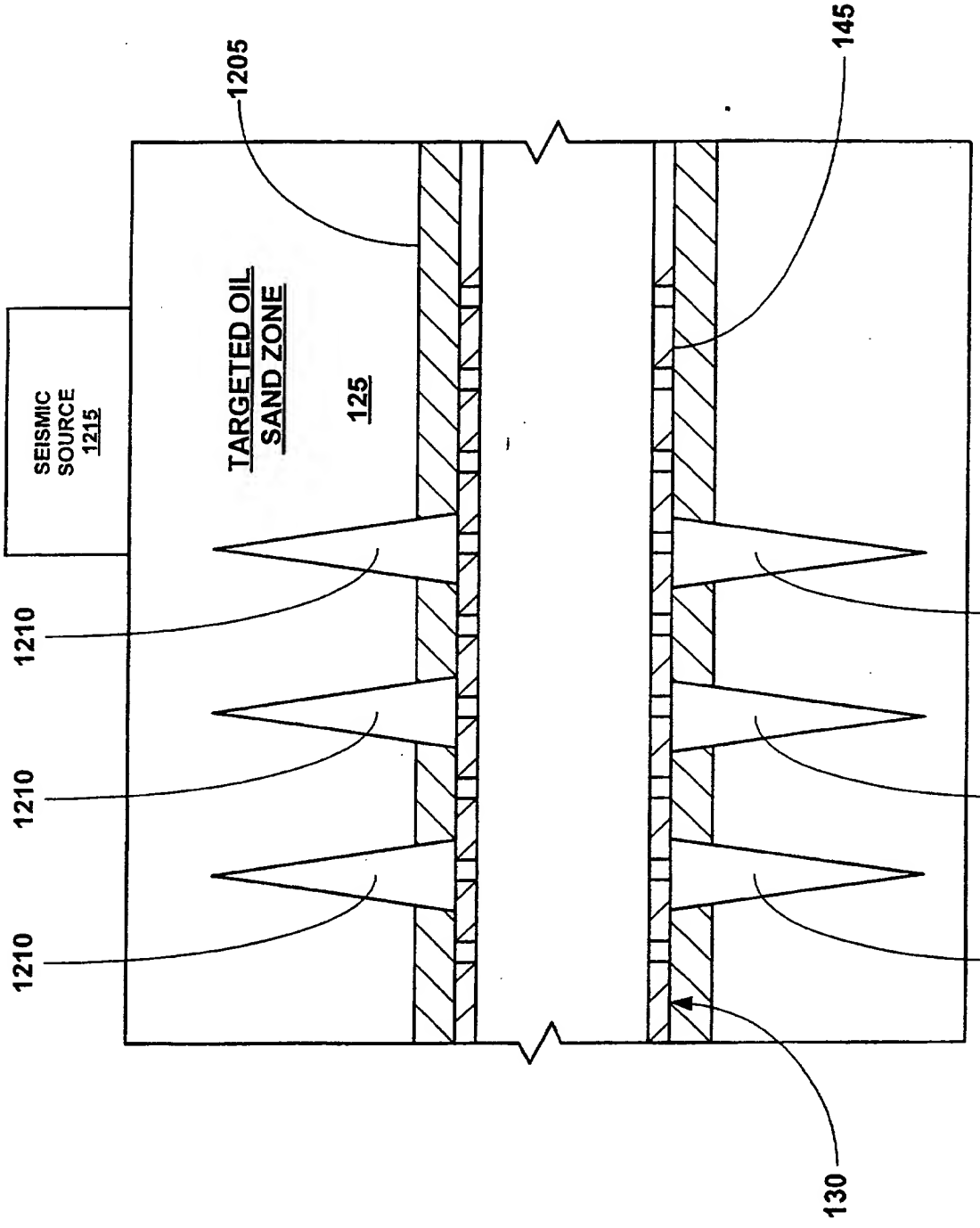



FIGURE 11


SEISMIC SOURCE 1215
TARGETED OIL SAND ZONE
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1205
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1210
1210
1210
130

FIGURE 12

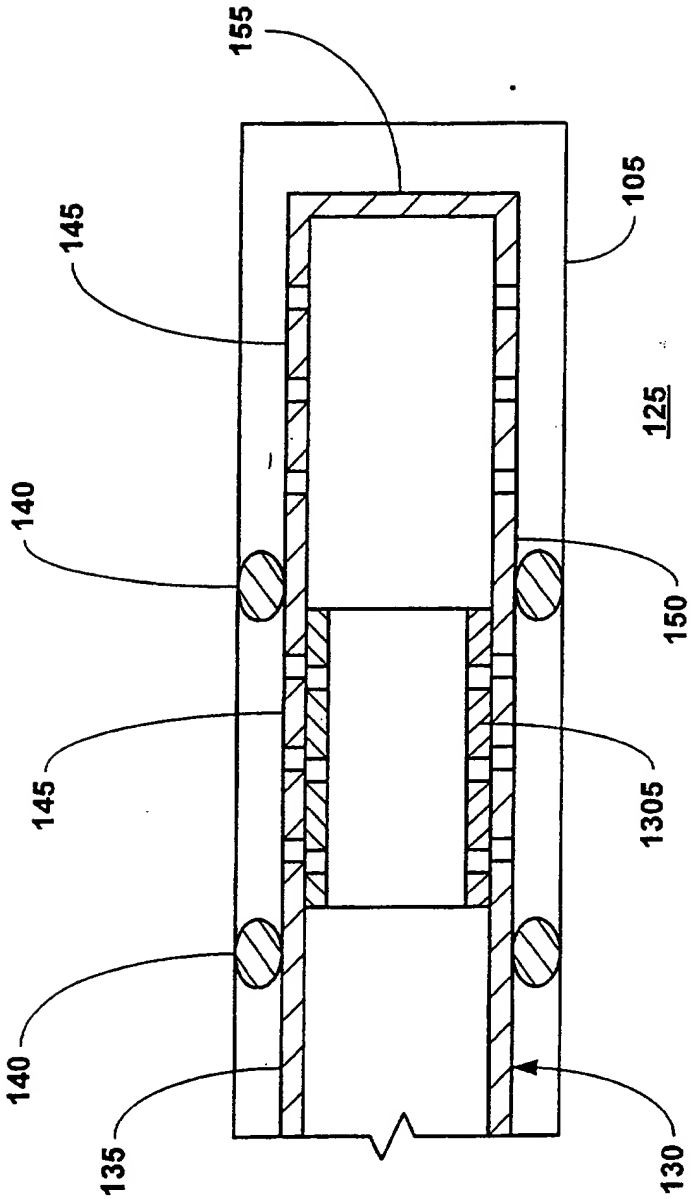


FIGURE 13

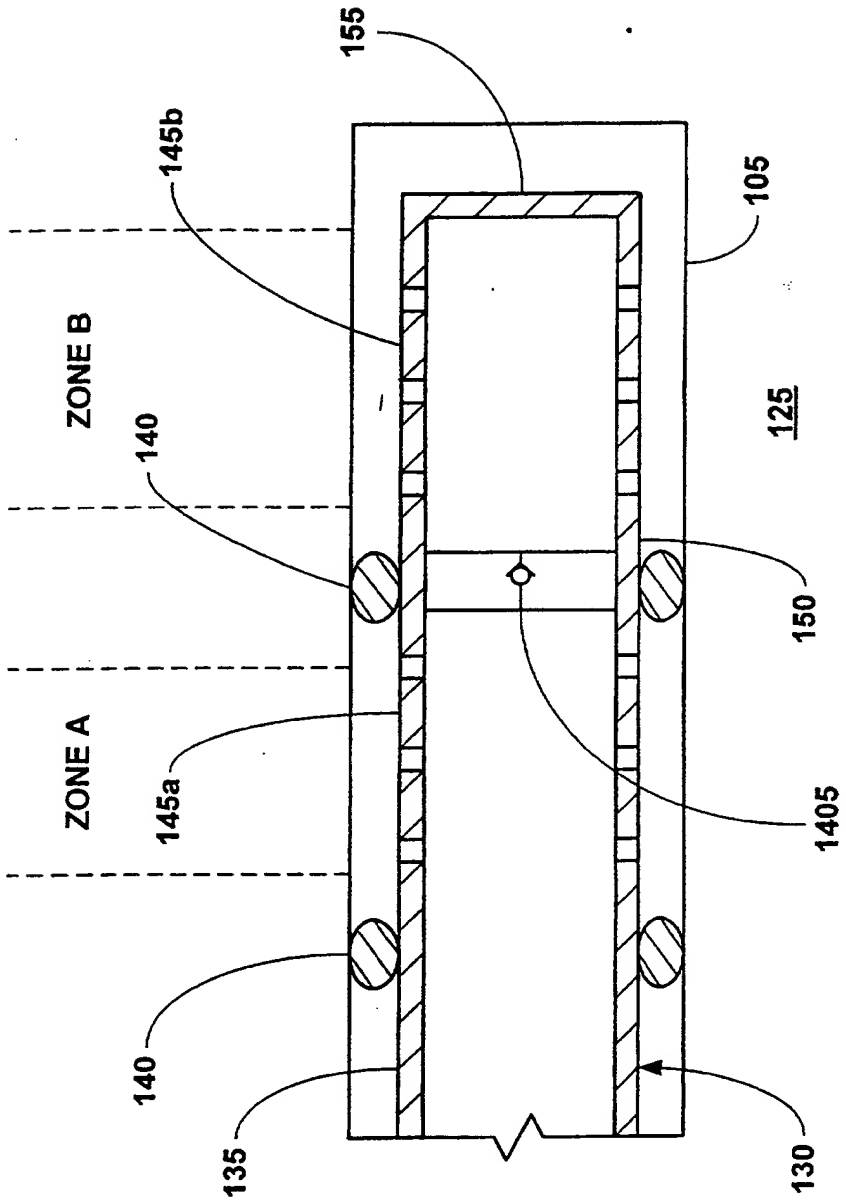


FIGURE 14

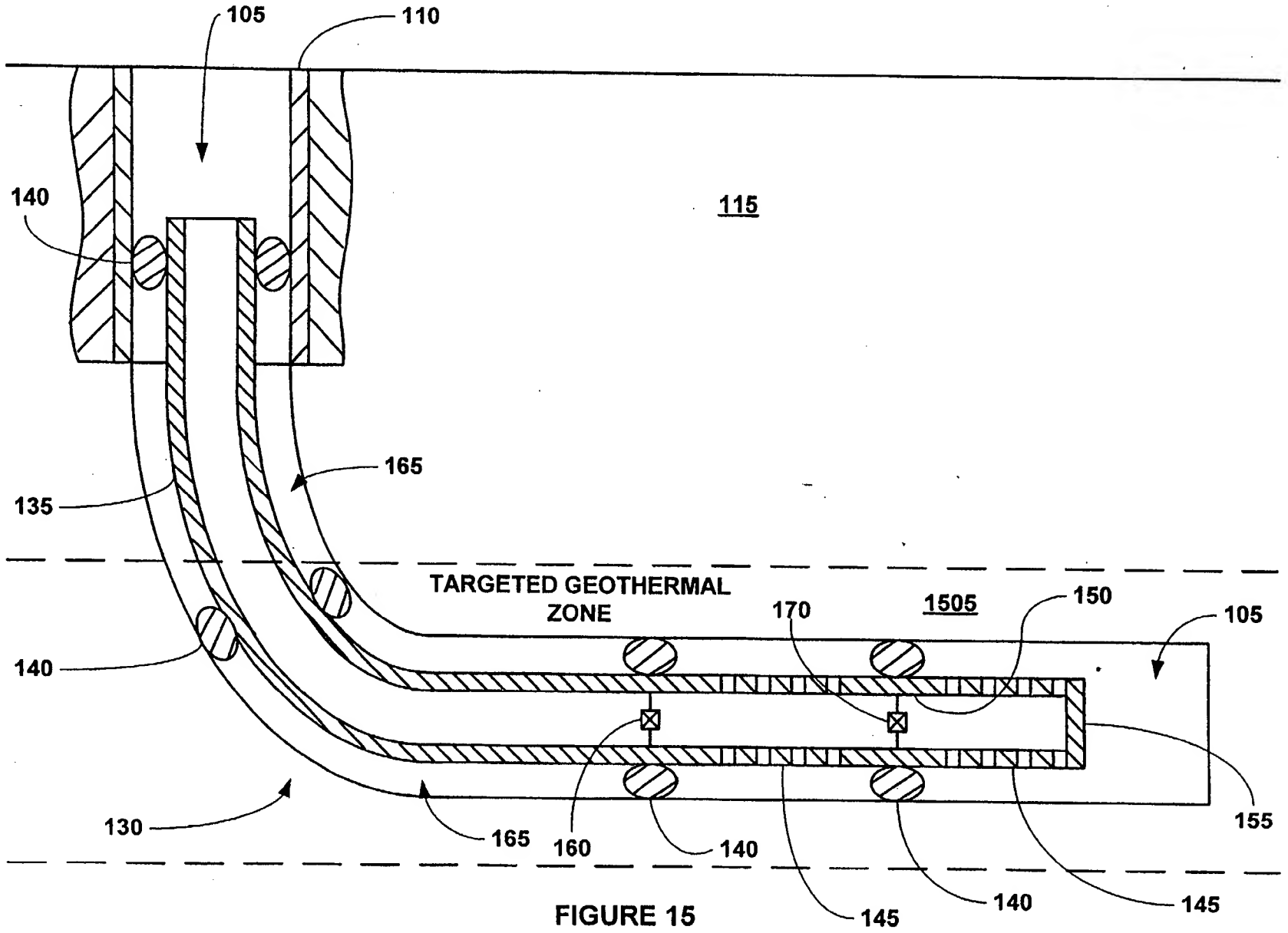
105
110
140
115
165
135
TARGETED GEOTHERMAL ZONE
1505
170
150
105
140
130
165
160
140
155
145
140
145

FIGURE 15

EXPRESS MAIL LABEL NO.: ___EL 747834647 U____ DATE OF DEPOSIT: __December 10, 2001__

I hereby certify that this paper and fee are being deposited with the United States Postal Service Express Mail Post Office to Addressee service under 37 CFR §1.10 on the date indicated above and is addressed to : Box PATENT APPLICATION, Assistant Commissioner for Patents, Washington, D.C. 20231.

NAME OF PERSON MAILING PAPER AND FEE SIGNATURE OF PERSON MAILING PAPER AND FEE

# ISOLATION OF SUBTERRANEAN ZONES

## Cross Reference To Related Applications

**[0001]** This application is a continuation-in-part of U.S. patent application serial number 09/969,922, attorney docket number 25791.69, filed on 10/3/2001, that was a continuation-in-part of U.S. patent application serial number 09/440,338, attorney docket number 25791.9.02, filed on 11/15/1999, that issued as U.S. Patent No. 6,328,113, that claimed the benefit of the filing date of U.S. provisional patent application serial number 60/108,558, attorney docket number 25791.9, filed on 11/16/1998, the disclosures of which are incorporated herein by reference.

**[0002]** The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent application serial no. 09/440,338, attorney docket no. 25791.9.02, filed on 11/15/1999, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on

4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001; (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001; (24) U.S, provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001; (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001; (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001; (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001; (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001; and (29) U.S. utility patent application serial no.

09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, the disclosures of which are incorporated herein by reference.

**Background of the Invention**

**[0003]** This invention relates generally to oil and gas exploration, and in particular to isolating certain subterranean zones to facilitate oil and gas exploration.

**[0004]** During oil exploration, a wellbore typically traverses a number of zones within a subterranean formation. Some of these subterranean zones will produce oil and gas, while others will not. Further, it is often necessary to isolate subterranean zones from one another in order to facilitate the exploration for and production of oil and gas. Existing methods for isolating subterranean production zones in order to facilitate the exploration for and production of oil and gas are complex and expensive.

**[0005]** The present invention is directed to overcoming one or more of the limitations of the existing processes for isolating subterranean zones during oil and gas exploration.

**Summary of the Invention**

**[0006]** According to one aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members coupled to the solid tubular members, one or more flow control valves operably coupled to the perforated tubular members for controlling the flow of fluidic materials through the perforated tubular members, one or more temperature sensors operably coupled to one or more of the perforated tubular members for monitoring the operating temperature within the perforated tubular members, one or more pressure sensors operably coupled to one or more of the perforated tubular members for monitoring the operating pressure within the perforated tubular members, and one or more flow sensors operably coupled to one or more of the perforated tubular members for monitoring the operating flow rate within the perforated tubular members, a shoe coupled to the zonal isolation assembly, and a controller operably coupled to the flow control valves, the temperature sensors, the pressure sensors, and the flow sensors for monitoring the temperature, pressure and flow sensors and controlling the operation of the flow control valves. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore.

**[0007]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars within the wellbore, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the primary solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to

the solid tubulars and perforated tubulars, monitoring the operating temperatures, pressures, and flow rates within one or more of the perforated tubulars, and controlling the flow of fluidic materials through the perforated tubulars as a function of the monitored operating temperatures, pressures, and flow rates.

**[0008]** According to another aspect of the present invention, a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars within the wellbore, the perforated tubulars traversing the producing subterranean zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, monitoring the operating temperatures, pressures, and flow rates within one or more of the perforated tubulars, and controlling the flow of fluidic materials through the perforated tubulars as a function of the monitored operating temperatures, pressures, and flow rates.

**[0009]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars within the wellbore, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for fluidicly coupling the perforated tubulars and the solid tubulars, means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid tubulars and perforated

tubulars, means for monitoring the operating temperatures, pressures, and flow rates within one or more of the perforated tubulars, and means for controlling the flow of fluidic materials through the perforated tubulars as a function of the monitored operating temperatures, pressures, and flow rates.

**[0010]** According to another aspect of the present invention, a system for extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars within the wellbore, the perforated tubulars traversing the producing subterranean zone, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, means for monitoring the operating temperatures, pressures, and flow rates within one or more of the perforated tubulars, and means for controlling the flow of fluidic materials through the perforated tubulars as a function of the monitored operating temperatures, pressures, and flow rates.

**[0011]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members each including radial passages coupled to the solid tubular members, and one or more solid tubular liners coupled to the interior surfaces of one or more of the perforated tubular members for sealing at least some of the radial passages of the perforated tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process

performed within the wellbore, and the solid tubular liners are formed by a radial expansion process performed within the wellbore.

**[0012]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the primary solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, positioning one or more solid tubular liners within the interior of one or more of the perforated tubulars, and radially expanding and plastically deforming the solid tubular liners within the interior of one or more of the perforated tubulars to fluidicly seal at least some of the radial passages of the perforated tubulars.

**[0013]** According to another aspect of the present invention, a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, positioning one or more solid tubular liners within the interior of one or more of the

perforated tubulars, and radially expanding and plastically deforming the solid tubular liners within the interior of one or more of the perforated tubulars to fluidicly seal at least some of the radial passages of the perforated tubulars.

**[0014]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for fluidicly coupling the perforated tubulars and the solid tubulars, means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, means for positioning one or more solid tubular liners within the interior of one or more of the perforated tubulars, and means for radially expanding and plastically deforming the solid tubular liners within the interior of one or more of the perforated tubulars to fluidicly seal at least some of the radial passages of the perforated tubulars.

**[0015]** According to another aspect of the present invention, a system for extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zone, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other

subterranean zone within the wellbore, means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, means for positioning one or more solid tubular liners within the interior of one or more of the perforated tubulars, and

means for radially expanding and plastically deforming the solid tubular liners within the interior of one or more of the perforated tubulars to fluidicly seal at least some of the radial passages of the perforated tubulars.

**[0016]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members each including radial passages coupled to the solid tubular members, and a sealing material coupled to at least some of the perforated tubular members for sealing at least some of the radial passages of the perforated tubular members, and a shoe coupled to the zonal isolation assembly.

**[0017]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the primary solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, sealing off an annular region within at least one of the perforated tubulars, and injecting a hardenable fluidic sealing material into the sealed annular regions of the perforated tubulars to seal off at least some of the radial passages of the perforated tubulars.

**[0018]** According to another aspect of the present invention, a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, sealing off an annular region within at least one of the perforated tubulars, and injecting a hardenable fluidic sealing material into the sealed annular regions of the perforated tubulars to seal off at least some of the radial passages of the perforated tubulars.

**[0019]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for fluidicly coupling the perforated tubulars and the solid tubulars, means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, means for sealing off an annular region within at least one of the perforated tubulars, and means for injecting a hardenable fluidic sealing material into the sealed annular

regions of the perforated tubulars to seal off at least some of the radial passages of the perforated tubulars.

**[0020]** According to another aspect of the present invention, a system for extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zone, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, means for sealing off an annular region within at least one of the perforated tubulars, and means for injecting a hardenable fluidic sealing material into the sealed annular regions of the perforated tubulars to seal off at least some of the radial passages of the perforated tubulars.

**[0021]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly positioned within a wellbore that traverses a subterranean formation including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members coupled to the solid tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore, and at least one of the perforated tubular members are radially expanded into intimate contact with the subterranean formation.

**[0022]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the primary solid tubulars and perforated tubulars within the wellbore, radially expanding at least one of the perforated tubulars into intimate contact with the second subterranean zone, fluidicly coupling the perforated tubulars and the solid tubulars, and preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid tubulars and perforated tubulars.

**[0023]** According to another aspect of the present invention, a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the producing subterranean zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, radially expanding at least one of the perforated tubulars into intimate contact with the producing subterranean zone, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, and fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone.

**[0024]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes means for positioning one or more solid tubulars within the

wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for radially expanding at least one of the perforated tubulars into intimate contact with the second subterranean zone, means for fluidicly coupling the perforated tubulars and the solid tubulars, and means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid tubulars and perforated tubulars.

**[0025]** According to another aspect of the present invention, a system for extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars within the wellbore each including one or more radial openings, the perforated tubulars traversing the producing subterranean zone, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for radially expanding at least one of the perforated tubulars into intimate contact with the producing subterranean zone, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, and means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone.

**[0026]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly positioned within a wellbore that traverses a subterranean formation and includes a perforated wellbore casing, including: one or more solid tubular members, each solid tubular member including

one or more external seals, one or more perforated tubular members coupled to the solid tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore, and at least one of the perforated tubular members are radially expanded into intimate contact with the perforated wellbore casing.

**[0027]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore that includes a perforated casing that traverses the second subterranean zone, is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the primary solid tubulars and perforated tubulars within the wellbore, radially expanding at least one of the perforated tubulars into intimate contact with the perforated casing, fluidicly coupling the perforated tubulars and the solid tubulars, and preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid tubulars and perforated tubulars.

**[0028]** According to another aspect of the present invention, a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing and a perforated casing that traverses the producing subterranean zone, is provided that includes positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the producing subterranean zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, radially expanding at least one of the perforated tubulars into intimate contact with the perforated casing,

fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, and fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone.

**[0029]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone in a wellbore that includes a perforated casing that traverses the second subterranean zone, is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for radially expanding at least one of the perforated tubulars into intimate contact with the perforated casing, means for fluidicly coupling the perforated tubulars and the solid tubulars, and means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid tubulars and perforated tubulars.

**[0030]** According to another aspect of the present invention, a system for extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing and a perforated casing that traverses the producing subterranean zone, that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars within the wellbore each including one or more radial openings, the perforated tubulars traversing the producing subterranean zone, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for radially expanding at least one of the perforated tubulars into intimate contact with the perforated casing, means for fluidicly coupling the solid tubulars

with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, and means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone.

**[0031]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members each including radial passages coupled to the solid tubular members, and one or more perforated tubular liners each including one or more radial passages coupled to the interior surfaces of one or more of the perforated tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore, and the perforated tubular liners are formed by a radial expansion process performed within the wellbore.

**[0032]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the primary solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and radially expanding and plastically deforming the perforated tubular liners within the interior of one or more of the perforated tubulars.

[0033] According to another aspect of the present invention, a method of extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and radially expanding and plastically deforming the perforated tubular liners within the interior of one or more of the perforated tubulars.

[0034] According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for fluidicly coupling the perforated tubulars and the solid tubulars, means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, means for positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and means for radially expanding and plastically

deforming the perforated tubular liners within the interior of one or more of the perforated tubulars.

**[0035]** According to another aspect of the present invention, a system for extracting materials from a producing subterranean zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zone, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, means for positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and means for radially expanding and plastically deforming the perforated tubular liners within the interior of one or more of the perforated tubulars.

**[0036]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly including: one or more solid tubular members, each solid tubular member including one or more external seals, two or more perforated tubular members each including radial passages coupled to the solid tubular members, and one or more one-way valves for controllably fluidicly coupling the perforated tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore.

**[0037]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone having a

plurality of producing zones in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning two or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the primary solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, and preventing fluids from passing from one of the producing zones that has not been depleted to one of the producing zones that has been depleted.

**[0038]** According to another aspect of the present invention, a method of extracting materials from a wellbore having a plurality of producing subterranean zones, at least a portion of the wellbore including a casing, is provided that includes positioning one or more solid tubulars within the wellbore, positioning two or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zones, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, preventing fluids from passing from one of the producing zones that has not been depleted to one of the producing zones that has been depleted.

**[0039]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second subterranean zone having a plurality of producing zones in a wellbore is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars

traversing the first subterranean zone, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for fluidicly coupling the perforated tubulars and the solid tubulars, means for preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, means for positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and means for preventing fluids from passing from one of the producing zones that has not been depleted to one of the producing zones that has been depleted.

**[0040]** According to another aspect of the present invention, a system for extracting materials from a plurality of producing subterranean zones in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the producing subterranean zones, means for radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the producing subterranean zone from at least one other subterranean zone within the wellbore, means for fluidicly coupling at least one of the perforated tubulars with the producing subterranean zone, means for positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and means for preventing fluids from passing from one of the producing zones that has not been depleted to one of the producing zones that has been depleted.

**[0041]** According to another aspect of the present invention, an apparatus for extracting geothermal energy from a subterranean formation containing a source of geothermal energy is provided that includes a zonal isolation assembly positioned within the subterranean formation including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members each including radial passages coupled to the solid tubular members, and one or more perforated tubular liners each including one or more radial passages coupled to the interior surfaces of one or more of the perforated tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore.

**[0042]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone including a source of geothermal energy in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the primary solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars, positioning one or more perforated tubular liners within the interior of one or more of the perforated tubulars, and radially expanding and plastically deforming the perforated tubular liners within the interior of one or more of the perforated tubulars.

**[0043]** According to another aspect of the present invention, a method of extracting geothermal energy from a subterranean geothermal zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes

positioning one or more solid tubulars within the wellbore, positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the subterranean geothermal zone, radially expanding at least one of the solid tubulars and the perforated tubulars within the wellbore, fluidicly coupling the solid tubulars with the casing, fluidicly coupling the perforated tubulars with the solid tubulars, fluidicly isolating the subterranean geothermal zone from at least one other subterranean zone within the wellbore, and fluidicly coupling at least one of the perforated tubulars with the subterranean geothermal zone.

**[0044]** According to another aspect of the present invention, a system for isolating a first subterranean zone from a second geothermal subterranean zone in a wellbore is provided that includes means for positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the second geothermal subterranean zone, means for radially expanding at least one of the solid tubulars and perforated tubulars within the wellbore, means for fluidicly coupling the perforated tubulars and the solid tubulars, and means for preventing the passage of fluids from the first subterranean zone to the second geothermal subterranean zone within the wellbore external to the primary solid tubulars and perforated tubulars.

**[0045]** According to another aspect of the present invention, a system for extracting geothermal energy from a subterranean geothermal zone in a wellbore, at least a portion of the wellbore including a casing, is provided that includes means for positioning one or more solid tubulars within the wellbore,

means for positioning one or more perforated tubulars each including one or more radial passages within the wellbore, the perforated tubulars traversing the subterranean geothermal zone, means for radially expanding at least one of the

solid tubulars and the perforated tubulars within the wellbore, means for fluidicly coupling the solid tubulars with the casing, means for fluidicly coupling the perforated tubulars with the solid tubulars, means for fluidicly isolating the subterranean geothermal zone from at least one other subterranean zone within the wellbore, and means for fluidicly coupling at least one of the perforated tubulars with the subterranean geothermal zone.

**[0046]** According to another aspect of the present invention, an apparatus is provided that includes a zonal isolation assembly including: one or more solid tubular members, each solid tubular member including one or more external seals, one or more perforated tubular members each including one or more radial passages coupled to the solid tubular members, and a shoe coupled to the zonal isolation assembly. At least one of the solid tubular members and the perforated tubular members are formed by a radial expansion process performed within the wellbore, and the radial passage of at least one of the perforated tubular members are cleaned by further radial expansion of the perforated tubular members within the wellbore.

**[0047]** According to another aspect of the present invention, a method of isolating a first subterranean zone from a second subterranean zone in a wellbore is provided that includes positioning one or more solid tubulars within the wellbore, the solid tubulars traversing the first subterranean zone, positioning one or more perforated tubulars within the wellbore each including one or more radial passages, the perforated tubulars traversing the second subterranean zone, radially expanding at least one of the primary solid tubulars and perforated tubulars within the wellbore, fluidicly coupling the perforated tubulars and the solid tubulars, preventing the passage of fluids from the first subterranean zone to the second subterranean zone within the wellbore external to the solid tubulars and perforated tubulars, and cleaning materials from the radial passages of at least one of the perforated tubulars by further radial expansion of the perforated tubulars within the wellbore.

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